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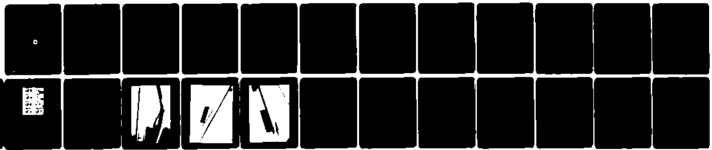

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CONSIDERATIONS RELATIVE TO THE USE OF CANES BY BLIND TRAVELERS IN AIR CARRIER AIRCRAFT CABINS

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16. Abstract

This report describes efforts accomplished in support of Flight Standards Service* Request for RD&E Effort No. AFS-200-78-8, "Impact of Blind Air Travelers Retaining Canes at Their Seats." Results are presented of specific areas of study; i.e.: (1) passenger evacuation time lapses with and without the presence of canes; (2) emergency exiting advantages and disadvantages with and without the presence of canes; (3) the utility of surrogate canes of the folding and telescoping varieties; (4) the movement of an unsecured cane during a high "g" deceleration; (5) the utility of a cane inside an aircraft during an emergency evacuation; and (6) implications of a passenger carrying a cane while descending an evacuation chute. The test program described involved evacuation tests from the Civil Aeromedical Institute (CAMI) evacuation simulation test facility, crash simulation tests conducted on the CAMI track, and static loading of different cane types to the failure point.

*This FAA service is now divided into two organizations, due to reorganization: Office of Airworthiness (AWS) and Office of Flight Operations (AFO).

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INTRODUCTION

This study was accomplished in response to Request for RD&E Effort No. AFS-200-78-8, "Impact of Blind Air Travelers Retaining Canes at Their Seats." Specific areas of concern as quoted from that request are:

"-Passenger evacuation time lapses with and without the presence of canes.
-Emergency exiting (via windows, doors, slides, steps, etc.) advantages and disadvantages with and without the presence of canes.
-The utility of surrogate canes of the folding or telescoping variety.
-The movement of an unsecured cane during a high "g" deceleration, including relocation and the possibility of a "missile" hazard.
-The utility of a cane inside an aircraft during an emergency evacuation.
-Implications of carrying a cane while on an evacuation chute, including any potential hazard to personnel on the chute."

The impracticality of testing with evacuation slides for this study was acknowledged in the request. This was because of the need for reducing the potential injury to the test subjects to the absolute minimum possible.

TEST PROGRAM

To obtain a data base for responding to the questions, a test program involving three distinct elements was conducted. Data pertaining to questions involving the emergency evacuation procedure were obtained from a series of evacuation tests using the Civil Aeromedical Institute (CAMI) evacuation simulation test facility. This facility consists of an aircraft fuselage section mounted on a hydraulic platform so that it may be lifted above ground level and reoriented with various angles of pitch and roll to simulate aircraft positions that may occur after emergency landing. The interior of the fuselage is fitted with three-abreast passenger seats on each side of a 15-inch-wide central aisle (Figure 1). Provisions are made for the use of photometric data collection systems for documenting and measuring passenger movement within the cabin. The test protocol developed for this study provided a balanced experimental design to provide data on the mobility of blind test subjects using no cane, a rigid cane, a telescoping cane, or a folding cane during evacuation through a floor-level or an overwing (Type III) exit configuration. The tests would also provide an indication of the effect on evacuation delays of seating location of the blind subjects.

The folding and telescoping canes to be used in the evacuation tests were selected in an attempt to identify those canes that might prove appropriate for use on board the aircraft. The telescoping cane was fabricated from thin-wall plastic tubing, apparently shrunk over a tapered mandrel. The tapered sections were then assembled so that when deployed, the smaller

EXIT
Floor Level: 32 in W
x 72 in H
Overwing: 20 in W
x 36 in H
21 in above floor

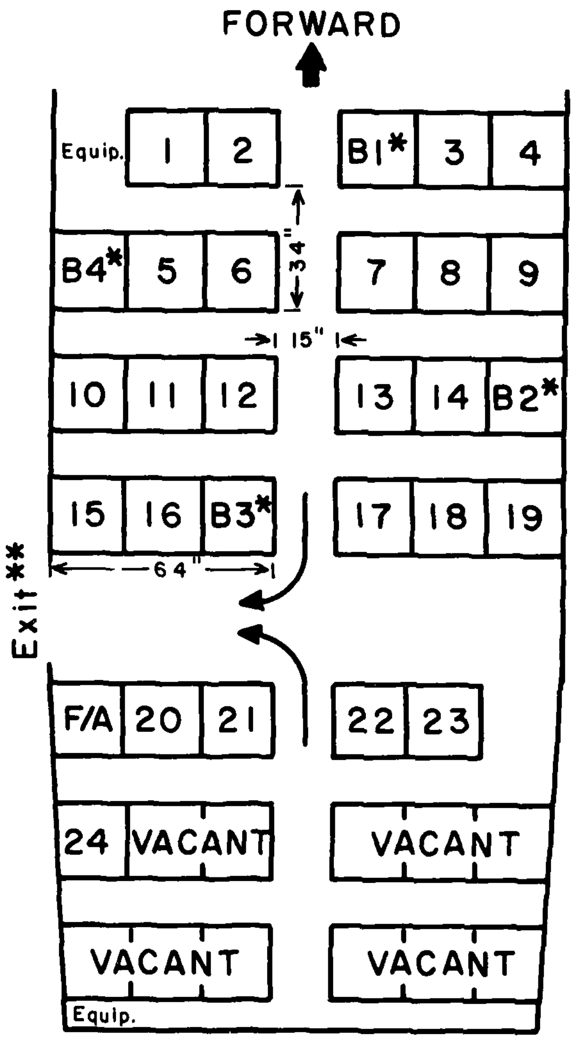

Figure 1. Seating arrangement.

*Blind subjects; seats not occupied every test.

inner sections would lock by friction to the outer sections. This cane was judged to be lightweight (2.7 ounces), compact (11 inches long and 1 inch in diameter) when stowed, and resilient when extended and locked. Other telescoping canes considered were heavier (up to 12 ounces) and used either locking rings which were judged too time-consuming and complex for an inexperienced user, or detent locking pins which resulted in a "wobbly" cane. The folding cane consisted of a number of aluminum tubing sections with either slip joints or taper and plug joints which were brought into position by elastic cord running through the center of the tubes. The first tests used canes with a relatively small-diameter elastic cord, but it was noted that the canes were only partially deployed in some tests, giving the effect of a broken cane hanging together by the cord. A switch to the canes with the heavier elastic cord and the tapered fittings alleviated that problem.

Sixteen tests using 24 sighted and 2 blind subjects on each test comprised the effort of one test day. These tests were divided into eight tests using the floor-level exit and eight tests using the overwing exit configuration. All tests were conducted at ground level with a level cabin floor to avoid unnecessary risk to the subjects and to avoid the introduction of complicating and uncontrollable factors which could mask the results of primary interest to this study. The same population of sighted subjects was used in all tests on a given test day, but different blind subjects were used for the floor-level and the overwing exit tests. Initially up to eight test days were planned for this study, but only five test days were completed because of administrative factors not pertinent to this study and since a review of the data collected through the fifth day indicated sufficient information had been obtained. Since the experimental design was balanced, this reduction did not adversely affect the usefulness of the results. A summary of the complete test protocol is given as Appendix A of this report.

The second element of this test program provided three crash simulation tests conducted on the CAMI track. For those tests the sled was equipped with two rows of two-place passenger seats.[1] An anthropomorphic dummy was seated in each row of seats, and a cane was placed on the sled in a manner similar to its potential placement if it were being used by a passenger in an aircraft anticipating a normal landing. This configuration was then exposed to a 9-g impact. High-speed photometric cameras recorded the kinematic response of the seats, dummies, and canes during each impact for later review and evaluation.

The final element of the test program accomplished static loading of different cane types to the failure point. Both compression and bending failure modes were evaluated. The magnitude of the load was measured and the failure mechanism documented. These data can form the basis of consideration of the potential of the canes to inflict injury to passengers or damage to evacuation slides.

[1]Hardman Model 9750-2

TEST RESULTS

Evacuation Tests. Photometric film coverage of each test was reviewed to obtain the time required for each subject to pass through the exit after the test began. These times were then used to construct a plot of the number of subjects out of the exit vs. the time after the evacuation signal as shown in Figure 2.[1] The slope of a line through the points in these plots represents the flow rate of the subjects through the exit. Any discontinuity in that line indicates a disruption in the uniform flow. The points on these plots which represented the blind subjects were then identified by a circle and annotated with the appropriate subject number.

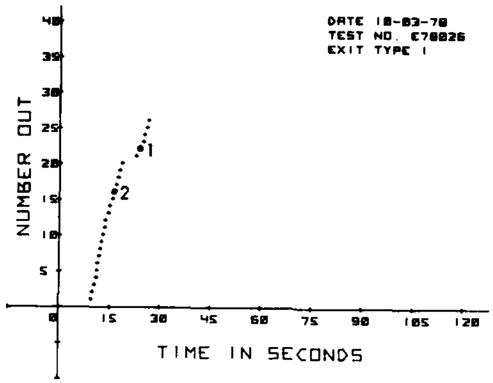

Figure 2. Data plot of evacuation test results

It was noted during the review of these plots that the disruption of the uniform flow did not always occur in the same way. In many cases there was a discrete delay between only two subjects, with the same flow rate resuming after the delay. In other cases the disruption involved several subjects, sometimes both before and after the blind subject, and resumption of the flow rate did not occur until several subjects had passed. Occasionally both blind subjects exited one after the other. Because of variables such as these, it was decided not to arbitrarily define a time delay between subjects to categorize the disruption as an evacuation delay, but rather to judge each test individually and place the disruption into a "delay" or "no delay" category based on the significance of the interruption relative to the overall flow. After this judgment had been made for all tests, the time interval causing the disruption was measured to establish intervals for "delay" or

[1]It will be noted that each plot contains an initial delay after test "0" time of about 7 seconds. This represents the exit-opening delay, during which the test cabin attendant restricted passage through the exit. This is a standard procedure in evacuation research. An exception to this practice occurred on Test No. E78038 when a young test subject passed under the arms of the cabin attendant, ignoring her direction to wait at the exit.

"no delay" categorization. It was found that the mean value of disruption in flow rate relative to subjects judged to produce "no delay" in the evacuation was 0.97 second, with a range of from 0 seconds to 2 seconds. The mean value of disruption in flow rate relative to subjects judged to produce "delay" in the evacuation was 5.28 seconds, with a range of from 2 seconds to 14 seconds.

Test records were then reviewed to determine the cane usage for each blind subject in each test. In this manner it was possible to determine the effect of cane usage relative to the frequency of evacuation delays for both types of exits present in the tests. The results of this analysis are presented in Table 1. An analysis of the flow disruption time intervals indicated that an average delay of 2.7 seconds was experienced when canes were not present for use by the blind subjects, and an average delay of 4 seconds was experienced if canes were present for the blind subjects to use. (See discussion section for further information regarding the nonuse of canes even when they were present for use.) The data were also analyzed to determine the effect of seat location. These results are shown in Table 2.

TABLE 1. Evacuation Delay According to Cane Use by Blind Subjects

	No. of Cases Observed	
Cane	Delay	No Delay
	Floor-Level Exit	
Standard	12	7
Folding	12	8
Telescoping	13	7
None	5	16
	Overwing-Type Exit	
Standard	15	5
Folding	15	5
Telescoping	14	6
None	12	8

TABLE 2. Evacuation Delay According to Seat Position

Seat No.	No. of Cases Observed: Delay	No Delay
Floor-Level Exit		
1	16	4
2	10	10
3	2	18
4	15	5
Overwing-Type Exit		
1	14	6
2	15	5
3	13	7
4	14	6

Crash Tests. In the first of these tests (A78-118), the [illegible] in the aft seat was provided with a 46-inch cane,[1] taped in its right hand and held in a normal upright position between the dummy and the forward seat. A second cane[2] was laid longitudinally on the floor along the seat. During the impact the cane held by the aft dummy was caught between the dummy and structure and fractured. The second cane moved along the floor until impacted by the hand of the forward dummy.

In the second test (A78-119), a short wooden cane[3] was placed in the hands of the rear dummy, with the cane centrally located between the knees. A 50-inch fiberglass cane[4] was placed in the forward dummy's left hand, tc the left of the knees. A third cane[5] was placed longitudinally on the floor by the seats. During the impact, the short wooden cane was trapped between the rear dummy and the forward seat, and during the response to the impact the cane was thrust laterally off the sled. The cane held by the forward dummy slid along the floor and then caught the tip in a depression on the floor. The dummy's head and neck then impacted the curved handle of the cane, causing a transient differential in peak acceleration of the head of approximately 20 g's. The cane on the floor moved forward without impediment, leaving the sled and coming to final rest on the laboratory floor ahead of the sled. The sequence of action is shown in Figure 3.[6]

[1] "Go Sees" ®
[2] True Temper ® TT48S
[3] No brand name
[4] Mahler TRS233
[5] True Temper ® TT48S
[6] Sequence camera malfunctioned during first test.

Figure 3. Sequence camera coverage of Test A78-119.
The frames are ordered in the indicated sequence.

In the final test (A78-120), an effort was made to evaluate the possibility of retaining the cane by the seatbelt. The rear dummy was provided with a short wooden cane,[1] the curved handle of which was hooked over the central portion of the snugly fastened seatbelt. The forward dummy was provided with a long, resilient plastic cane,[2] which was passed under the seatbelt, with the upper end resting against the dummy's right shoulder and the tip of the cane resting on the floor. Although efforts were made to select a position for the cane that would permit the seatbelt to be snugly attached around the dummy's pelvis, this was not possible and some slack was unavoidably present as the lapbelt was held away from the dummy by the cane. During the impact, the aft dummy moved forward (as is normally expected) and received abdominal loading from the cane handle. Although the magnitude of this loading could not be measured, it was sufficient to wipe the hard-gloss paint from the handle of the cane onto the clothing of the dummy. The forward dummy moved to the edge of the seat, failing it downward, and then continued to move downward to the floor. The cane fractured at the point of retention by the belt, as it conformed to the flexion of the dummy over the seatbelt. The fracture pattern revealed fragments of long, needle-like, plastic material, perhaps fiberglass-reinforced resin. The sequence of action is shown in Figure 4.

[1]No brand name available
[2]Site Cane ®

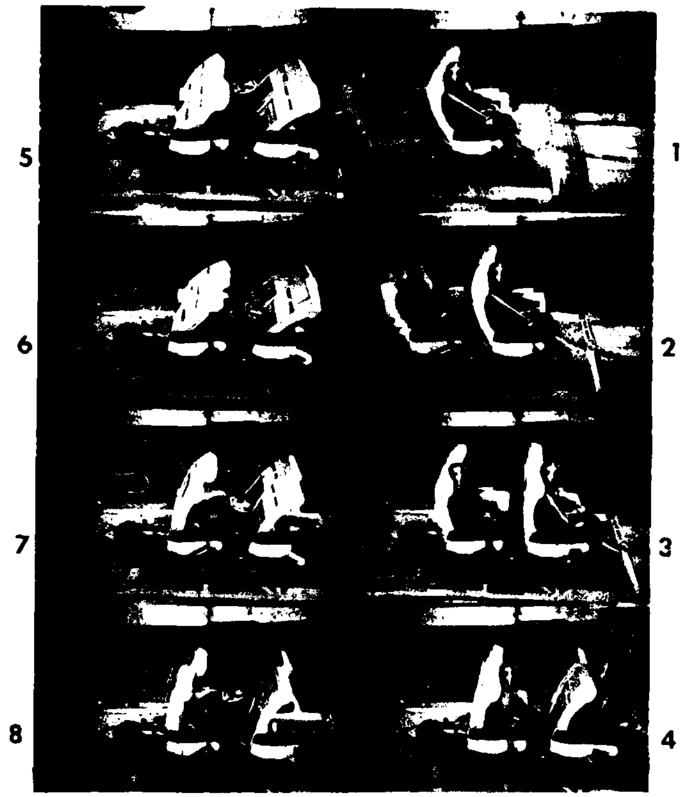

Figure 4. Sequence camera coverage of Test A78-120.
The frames are ordered in the indicated sequence.

Static Loading Tests. Twenty-four canes were selected to determine the maximum load that was required to destroy the canes under conditions of bending or axial compressive loading. Four canes were subjected to bending, loaded at their midpoint and supported on blocks spaced 20.25 inches apart. This loading condition was designated B1 and was intended to simulate the case where a cane became lodged across the narrow dimension of an overwing exit. The forces and energy measured in the test would then represent the effort required to break the cane blocking an exit so that passenger evacuation might continue. Four additional canes were subjected to similar tests, but with the supports spaced 37 inches apart to simulate the long dimension of an overwing exit. This test mode was designated B2. The remaining 10 canes were subjected to compression loading along their axial dimension to determine the forces that might be generated if the cane were broken by pushing on its end, as might happen if the cane were being carried down an evacuation slide and became wedged between the slide and the passenger. This test mode was designated C. The results of these tests are shown in Table 3.

TABLE 3. Static Loading

S/N	Cane Description: Manufacturer [1]	Cane Description: Length (in)	Cane Description: Material	Test Mode	Max. Load (lb)	Energy (lb)
1	No name	34.5	Wood	B1	117	82
2	Hycor: Model 6413B	32.5	Aluminum	B1	155	289
3	No name	45.0	Plastic	B1	29	29
4	Mahzell: Aluminaid ®	50.0	Aluminum	B1	53	416
5	Mahler	50.0	Aluminum	B1	44	64
6	Hycor: Model 5302	48.5	Aluminum	B1	77	218
7	Hycor: Model 5303	48.0	Aluminum	B1	30	112
8	No name	44.0	Aluminum	B1	113	1,008[2]
9	Rainshine: Site Cane ®	53.0	Plastic	B1	169	980
10	"Go Sees" ®	46.0	Plastic	B1	187	224
11	Same as S/N 8	44.0	Aluminum	B2	62	588
12	Guidelite ®	48.0	Aluminum	B2	60	754
13	No name	49.0	Wood	B2	52	192
14	Same as S/N 9	53.0	Plastic	B2	69	505
15	Same as S/N 12	48.0	Aluminum	C	77	675[2]
16	True Temper ® TT48S	48.0	Plastic	C	22	183
17	Same as S/N 3	45.0	Plastic	C	12	60
18	Same as S/N 9	53.0	Plastic	C	30	486[2]
19	Same as S/N 2	32.5	Aluminum	C	280	---
20	Same as S/N 4	50.0	Aluminum	C	35	328
21	Same as S/N 6	48.5	Aluminum	C	75	407
22	Same as S/N 7	48.0	Aluminum	C	92	158
23	Same as S/N 1	34.5	Wood	C	150	220
24	Same as S/N 13	49.0	Wood	C	124	605

TEST MODE:
- B1 Bending, center loading, 20.25-inch support spacing.
- B2 Bending, center loading, 37-inch support spacing.
- C Compression

An additional result of this phase of testing was the identification of failure modes for each of the cane types and materials evaluated. In general, the canes made of thin-wall aluminum tubing failed by simple bending of the tube. Jointed canes often failed by splitting the joint or by failing the internal cable that held the joints together. These failure modes did not result in a significantly more hazardous condition than was present initially with the cane. Canes made of reinforced plastic showed different failure modes. The hollow construction failed by flexing and splintering as shown in Figure 5. Those of solid construction failed by splintering longitudinal sections of fiber as shown in Figure 6. Canes made of wood failed by splintering and breaking along the grain (Figure 7).

[1] Registered trademark shown where appropriate.
[2] To maximum 18-inch stroke of press.

Figure 5. Typical failure mode of hollow fiber-reinforced canes.

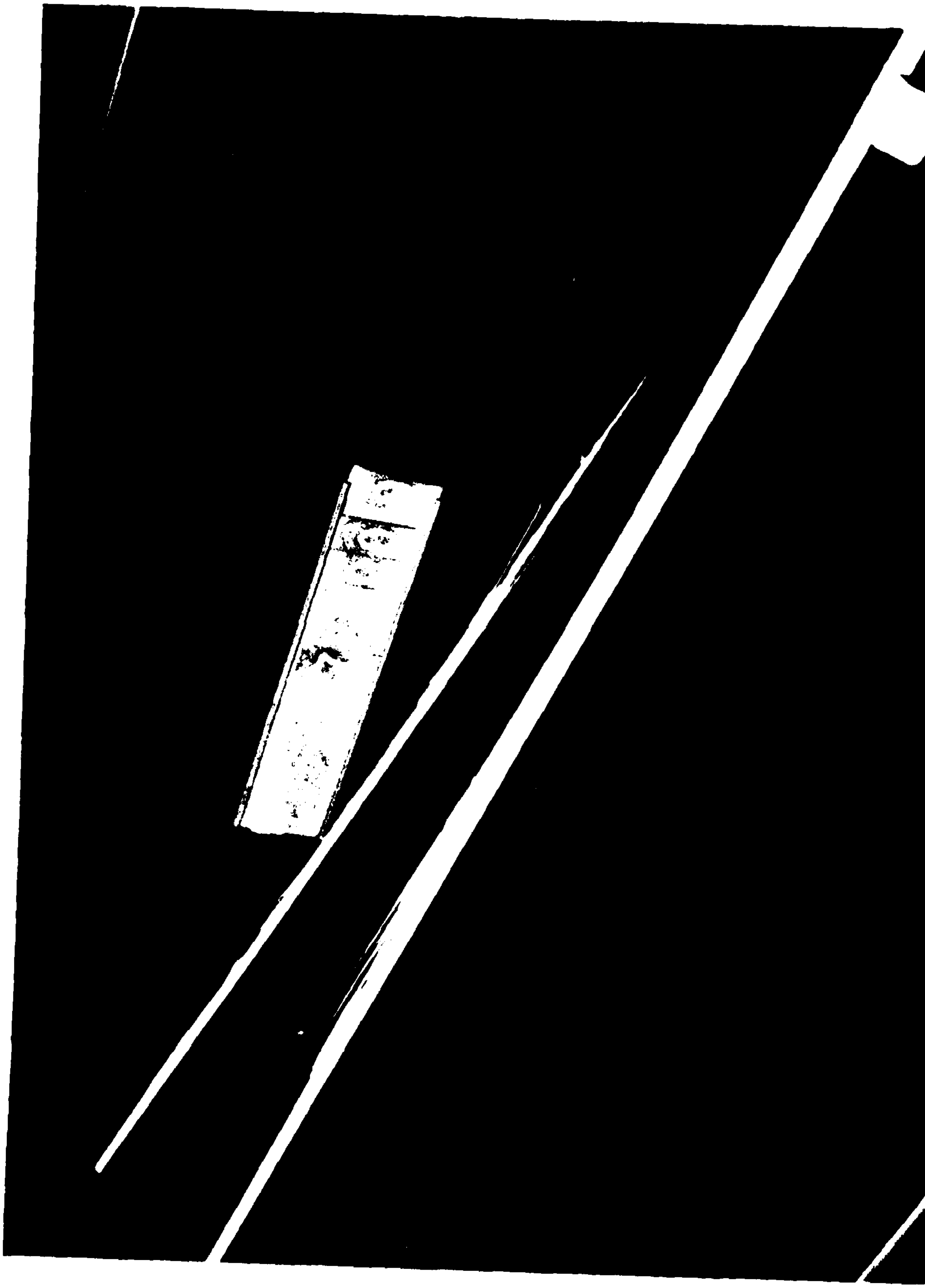

Figure 6. Typical failure mode of solid fiber-reinforced canes.

Figure 7. Typical failure mode of wood canes.

DISCUSSION

Evacuation Tests. The data shown in Table 1 indicate that for the floor-level exit, the evacuations proceeded more often without delay only when canes were NOT used by blind subjects. This indication was reinforced during review of the photometric film coverage of the tests, where it was noted that in over half of the cases where canes were available to the blind subjects but there was "no delay," the canes were carried but not used for guidance. For comparison, in those cases where canes were available and an evacuation delay was encountered, the canes were judged to be not used in only one-fourth of the observations. In the remainder of the tests, the canes were only partially used, with some reliance placed on the other subjects and on the seat backs to aid in guiding movement within the cabin. In the tests that used the overwing-type exit, no difference was noted in the frequency of occurrence of evacuation delays relative to the use or nonuse of canes. The added obstacle of the small exit opening, set above the floor, appears to be a sufficient barrier to mask any influence of cane use on frequency of occurrence of delay.

Flow disruption intervals were then again reviewed to obtain measurements related to cane usage. When both exit types are considered together, the mean delay interval was 2.7 seconds when canes were not used[1] and 4.4 seconds when canes were used. For overwing-type exits, the mean delay intervals were 3.3 and 5.6 seconds respectively. Thus, although there appears to be no real difference in the frequency of occurrence of delays through the overwing-type exit, the magnitude of the delays appears greater if canes are used.

The data shown in Table 2 indicate that fewer delays were encountered when the blind subjects were seated in seats numbered 2 and 3 for the tests that used a floor-level exit. This result is related to the bunching condition at the exit during the exit-opening delay. This delay was sufficient to allow the subject seated in the vicinity of the door, as well as the subjects in seats 2 and 3, to move to the door and then wait until movement through the door was started. Thus the blind subject delay was masked by the 7-second exit-opening delay used in these tests. This result must be judged in consideration of the actions that take place in real emergency evacuations in the field, most specifically the potentially disastrous effect of an early delay in the evacuation process when a large number of passengers remain on board the aircraft and are possibly subjected to the effects of smoke and fire. Again the obstacle of the overwing-type exit masked an effect of the seat position of the blind subjects in tests with that exit.

Several observations were made during the tests and during review of the film coverage of the tests. These factors, although not numerically quantifiable, are significant in judging the actions of blind subjects in the tests and should be considered in evaluating potential problems associated with blind air travelers. Not in order of precedence, they are:

a. The sighted subjects were well aware of the presence and the handicap of the blind subjects and readily offered assistance during the evacuation.

[1] Including those cases when canes were not available for use.

This assistance was offered without regard to the presence of canes and took the form of direct, active assistance to the blind subject as well as passive aid such as waiting for the blind subject to move out of the way rather than pushing ahead.

b. The blind subjects appeared to accept assistance more readily if they did not have a cane.

c. Blind subjects with canes took time caring for the canes which might otherwise have been used to initiate their evacuation. Subjects with standard canes would often lean the cane against the aircraft interior, use both hands to release their seatbelt, recover the cane, and only then begin the evacuation. Subjects with folding or telescoping canes would carry the cane continuously but would spend time deploying the cane and then checking to make sure it was deployed properly.

d. Blind subjects often had difficulty manipulating the webbing-to-metal seatbelt systems used in these tests, but indicated familiarity with the push-button seatbelt buckles as are used in automobiles.

e. The presence of a cabin attendant at the exit to assist and direct the movement of the blind subject through the exit was of considerable benefit.

f. When deploying folding or telescoping canes and subsequently checking their condition, the blind subjects, apparently unaware of the nearby presence of other subjects, would sometimes tend to poke or bump the other subjects.

g. The folding and telescoping canes would sometimes not properly deploy and thus give inadequate guidance to the subjects.

h. Once outside the evacuation simulator and on more familiar ground (flat grass-covered earth), the blind subjects found the canes to be useful in their normal movement, and those subjects without canes required individual assistance to move away from the simulator.

i. Consistency was noted in the performance of many blind subjects, some being slow or fast in their motion regardless of the conditions. This same characteristic is often noted in sighted subjects.

Crash Tests. The reaction of any mass during a crash will be covered by Newton's Laws of Motion. One statement of the First Law can be stated as:

> If no force acts on a particle, the particle remains at rest or continues to move with uniform velocity in a straight line.

Thus if a cane is free in a cabin during a crash, it will continue to move at the velocity of the crash until it hits something or something hits it. This was demonstrated in the first two tests. The problems that result from this motion are not so easily defined. Injury or damage that occurs will depend on the force that occurs during the "hit" (secondary impact), the type of hit

(e.g., a glancing blow, a flat broadside blow, or along the long axis of the cane), and the object site which receives the hit. These are random occurrences, not easily controlled or predicted. Perhaps the most easily recognized injury potential would be to the eyes of the passengers, which could obviously be injured if impacted by the tip of the cane. Perhaps not as easily recognized is the potential of injury due to direct impact with the neck. The thyroid and cricoid cartilages embrace the airway passage (trachea) so that their collapse can inhibit breathing. These cartilages are relatively delicate, with fracture beginning at about 90 pounds force and total collapse imminent at 110 pounds force application. Several canes are capable of transmitting forces of this magnitude (see static loading results). The action of the cane on the head and neck as occurred in the second test would probably have caused injury either to the neck or to the central nervous system from the resultant acceleration.

The remaining major injury potential could result from penetrating-type injury, either from the undamaged cane or from a cane that was damaged in the crash. The severity of potential penetrating injury would be dependent on (1) the area of the penetrating source with sharp-pointed sources being more dangerous than blunt sources; (2) the magnitude of the force causing the penetration; and (3) the site on the body where the source acts, with soft tissue being more liable to injury. Canes are usually equipped with blunt tips at least one-half inch in diameter so that injury from this source will be minimal unless the eyes are contacted. If the cane tip is worn, it is possible for some tips to be reshaped into a point or sharp edge with resultant increase in injury potential. If the cane is damaged, sharp points can result and again increase injury. This occurred during the crash tests and was particularly evident during the attempt to retain the cane with the seatbelt. The potential of serious injury to abdominal tissue is considered to be high in such cases.

The final crash test also illustrated the typical injury-accentuating effect of a slack seatbelt, caused in this test by an attempt to stow the cane under the belt. During a crash, an occupant with a slack seatbelt will tend to impact the belt with sufficient speed to cause some injury, perhaps to internal organs. If the seatbelt rides up above the pelvis, or if the occupant moves forward and down over the front edge of the seat often causing the seat to fail in the process, the condition known as "submarining" takes place. This can result in life-threatening internal injury.

Static Tests. The results of the static tests indicated that canes in common use are capable of transmitting forces of sufficient magnitude to result in injury. The forces varied greatly, from 12 to 280 pounds in compression, and from 29 to 187 pounds in bending. The stronger canes could potentially block an exit if placed crosswise to the exit. Studies conducted at the Civil Aeromedical Institute indicate that only about 5 percent of cabin attendants could push (as at a doorway) with a force of 140 pounds, so that the cabin attendant could not break through a strong cane placed across the exit. It would be necessary to cause the passengers to move back so that the cane could be removed, an action highly problematic under the true conditions of an emergency evacuation.

Furthermore, if canes are broken from whatever, it is possible to create sharp-pointed ends that would greatly increase the possibility for penetrating injury or damage to inflated evacuation slides.

CONCLUSIONS

In response to the specific questions of the Request for RD&E Effort:

a. Passenger evacuation time lapses with and without the presence of canes: A significant reduction in the number of evacuation delays related to the blind subjects occurred only when canes were not used.

b. Emergency exiting (via windows, doors, slides, steps, etc.) advantages and disadvantages with and without the presence of canes: The use of a window exit by a blind passenger appears to be of great disadvantage. Not only is a delay more likely to occur, but the problems of jumping from the wing to the ground and then leaving the vicinity of the aircraft could pose major problems. Steps pose no problems differing from steps in other installations. Using slides will be difficult in any event, but the potential for damage to a slide or injury to passengers using the slide is increased if canes are in use. The problems of puncturing a slide with a cane are similar to those which exist with high-heeled shoes, but are compounded by those canes that can fracture and produce sharp penetrating ends. If a cane is accidentally placed so that it blocks the exit, it may be strong enough to resist breaking out and thus delay the evacuation.

c. The utility of surrogate canes of the folding or telescoping variety: The use of surrogate canes did not reduce the incidence of delay in the evacuation process. There is some indication that the attempted use of these devices by persons not practiced in their deployment and application may contribute to delay.

d. The movement of an unsecured cane during high "g" deceleration and the possibility of a "missile" hazard: An unsecured cane in an aircraft cabin during a crash will tend to continue in motion at the same velocity along the aircraft landing path until it hits something. The action of the cane from that point on cannot be predicted. Many canes are capable of transmitting forces of sufficient magnitude to cause serious injury.

e. The utility of a cane inside an aircraft during an emergency evacuation: Canes were found to be associated with delays in evacuations through floor-level exits more often than was the condition of no canes. Attempts to rely on canes for guidance during an evacuation, rather than to rely on fellow passengers for assistance, will be more likely to delay the blind passenger as well as following passengers. In a true emergency with the presence of life-threatening smoke and fire, passengers may not be tolerant of such a delay and may injure the blind passenger with cane in their rush to leave the aircraft.

With these considerations (paragraphs a through e), canes were judged to have negative utility inside an aircraft during an emergency evacuation. The possibility of exit blockage has already been mentioned.

f. Implications of carrying a cane while on an evacuation chute, including any potential hazard to personnel on the chute: The problems of puncturing a slide with a cane are similar to those which occur with high-heeled shoes but are compounded by the availability of canes that can fracture and produce sharp-pointed ends. The potential for penetrating human injury from such a cane is also increased, but many canes are capable of transmitting forces of life-threatening magnitude even if unbroken.

APPENDIX A

TEST PROTOCOL: IMPACT OF BLIND AIR TRAVELERS RETAINING CANES AT THEIR SEATS

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INTRODUCTION

This protocol is prepared in response to Request for RD&E Effort No. AFS-200-78-8. Its purpose is to outline a program that will provide data relative to the issues of:

a. Passenger evacuation time lapses with and without the presence of canes.

b. Emergency exiting advantages and disadvantages with and without the presence of canes.

c. The utility of surrogate canes of the folding or telescoping variety.

d. The movement of an unsecured cane during a high "g" deceleration.

e. The utility of a cane inside an aircraft during an emergency evacuation.

f. Implications of carrying a cane while on an evacuation slide. Since these issues involve both evacuation and deceleration factors, the research program will be divided accordingly.

EVACUATION RESEARCH PROGRAM

The request describes four cane factors (without cane, with cane, with folding cane, and with telescoping cane) and two basic exit configurations (floor-level door and window) that require data. The outlined program (Table A-1) provides for a 64-test program to gather these data, as well as pertinent information regarding the effect of seating position (aisle or window seat) on interior cabin movement. This program would provide eight data points for each cane variable at each seating position for each type of exit. The eight data points will enable the effect of the "learning curve" to be evaluated. Each day of testing will require 24 sighted subjects and 4 blind subjects. Blind subjects will be solicited through the Oklahoma League for the Blind and sighted subjects would be obtained under contract.

Blind subjects would receive a special briefing prior to each test series, during which the purpose of the test would be explained. They would then be led to the simulator and seated in their assigned positions. Those blind subjects with canes would be told to use them when they thought canes would be of help. The remainder of the subjects would be given a standardized two-part briefing, the first part being given in the lobby of the CAMI building:

Blind Cane Study--Subject Indoctrination Tape
(Narration by J. D. Garner)

We hope you will enjoy the morning participating in research to answer some questions about evacuating commercial aircraft. The conditions you will be experiencing may not seem to relate to a crash situation, but the outcome will have a definite bearing on regulations and decision-making at our headquarters. We will be finding factual data from these tests and sending the information to the headquarters for their reference in that decision-making process.

You're being asked to perform as instructed in 16 evacuations today from a fuselage on the ground without escape slides. We anticipate the tests will take about 45 seconds each. Each test will involve changes and may appear repetitious. However, to assure valid information, while using tax money, we ask that you perform with the same vigor and enthusiasm throughout the test program.

The cabin will be brightly lit for photographic documentation. This is possible today because of the type of comparisons under study. It certainly would not be the environment following a crash.

The number jackets you have on help us in data analysis and camera identification without using names. The jackets should be checked to make sure that the numbers are flat against your body and easily read with no wrinkles or folds which may obscure the numbers.

In order to seat everyone efficiently, please line up starting with number one, which will be the most forward seat in the fuselage as you enter the cabin from the rear door. I will advise you further after getting seated in the cabin.

Break for movement from the
CAMI lobby to the test site.

You are in an old C-124 cargo aircraft that has flown many missions, that we use for our evacuation mockup. We do many types of testing in here.

Today you will be using the aft left door and we ask that after each test runout that you wait outside and we'll give you a signal when we're ready to reload into the same seats you occupy at this time, so you might take a look around to see where you are and which seat to come back to after each test.

One thing I would like to point out is there is a little difference in seat arms. In running down the aisle, be careful that you don't hit your knees directly headon into one of these seat arms. So take note of them that we do not have anybody injured by running into those.

The way we measure your performance today is by total time for you to perform each test. Therefore, we would like for you to be aware of this and go about each one with the same vigor that you did in the previous one.

Outside the exit is a ramp, 8 feet long, that goes down to the ground 1 foot distance (that is, the door sill is 1 foot off the ground), so be aware that you are going down an inclined ramp.

The start signal is a 1-second bell signal, signalling "go." It will silence for 7 seconds, simulating a door-opening and slide deployment time during an actual emergency. On the seventh second, the bell will start ringing again and ring throughout the rest of the test. We'll demonstrate that at this point now.

Bell Sequence Demonstrated.

Again let me remind you! Remain outside until we give you the signal to come in.

The test would be conducted in the usual manner. Observers will be assigned to monitor the movement of each blind subject throughout the test and will stop the test in the event of potential injury to the subjects or other problems. All tests would be recorded by at least two cameras with appropriate timing marks, and the overall evacuation time will be measured to determine flow rate. Delays in evacuation will be measured from film data, and plots of cumulative subjects evacuated vs. time will be developed.

This program will not provide data on the effects of vision obscuration by smoke or unlevel floor during evacuation.

DECELERATION RESEARCH PROGRAM

This effort will be directed to the problem of defining cane movement and subsequent damage or injury during a crash. Static tests will be conducted to determine breaking strength and fracture patterns for the various types of canes, and a dynamic crash test will be conducted to demonstrate the kinetics of cane retention at the passenger's seat.

At least one sled test will be accomplished. Sled configuration will provide two rows of air carrier passenger seating, and testing will be done at approximately 9 g's from 44 feet/second. Anthropomorphic dummies seated in the second row will be equipped with canes, one stowed under the seatbelts and one held in the hands. In addition, one cane will be placed longitudinally

on the floor of the sled. Reaction to the simulated impact will be documented by high-speed motion pictures.

Static tests will be conducted on samples of each cane type to determine breaking strength under pure bending loading (centrally loaded) and pure compression. Fracture patterns (splintering, laminar separation, buckling, etc.) will be documented photographically. Load/deflection curves will be plotted.

TABLE A-1. Evacuation Test Sequence

CANE STUDY

NC: No Cane
SC: Standard Cane
FC: Folding Cane
TC: Telescoping Cane

Day	Test No. E780-	Exit	Blind Subj. No.	Seat	Cane	Blind Subj. No.	Seat	Cane
1	20	Door	1	1	NC	2	4	FC
	21			2	SC	3	3	TC
	22			3	TC		1	NC
	23			4	FC		2	SC
	24			2	NC		1	FC
	25			3	SC		4	TC
	26			4	TC		2	NC
	27			1	FC		3	SC
	28	Window	3	1	SC	4	3	FC
	29			2	TC		4	NC
	30			3	FC		2	TC
	31			4	NC		1	SC
	32			2	FC		3	NC
	33			1	TC		4	SC
	34			3	NC		2	FC
	35			4	SC		1	TC
2	36	Door	5	1	SC	6	3	FC
	37			2	TC		4	NC
	38			3	FC		2	TC
	39			4	NC		1	SC
	40			2	FC		3	NC
	41			1	FC		4	SC
	42			3	NC		2	FC
	43			4	SC		1	TC

Day	Test No. E780-	Exit	Blind Subj. No.	Seat	Cane	Blind Subj. No.	Seat	Cane
2	44	Window	7	1	TC	8	4	SC
	45			2	FC		1	TC
	46			4	SC		3	NC
	47			3	NC		2	FC
	48			4	FC		1	NC
	49			3	TC		4	FC
	50			2	SC		3	TC
	51			1	NC		2	SC
3	52	Door	9	1	TC	10	4	SC
	53			2	FC		1	TC
	54			4	SC		3	NC
	55			3	NC		2	FC
	56			4	FC		1	NC
	57			3	TC		4	FC
	58			2	SC		3	TC
	59			1	NC		2	SC
	60	Window	11	1	FC	12	4	TC
	61			2	NC		1	FC
	62			3	SC		2	NC
	63			4	TC		3	SC
	64			1	SC		4	NC
	65			2	TC		1	SC
	66			3	FC		2	TC
	67			4	NC		3	FC
4	68	Door	13	1	FC	14	4	TC
	69			2	NC		1	FC
	70			3	SC		2	NC
	71			4	TC		3	SC
	72			1	SC		4	NC
	73			2	TC		1	SC
	74			3	FC		2	TC
	75			4	NC		3	FC
	76	Window	15	2	NC	16	3	SC
	77			3	SC		4	TC
	78			4	TC		1	FC
	79			1	FC		2	NC
	80			3	NC		4	SC
	81			4	SC		2	FC
	82			1	TC		3	NC
	83			2	FC		1	TC

Day	Test No. E780-	Exit	Blind Subj. No.	Seat	Cane	Blind Subj. No.	Seat	Cane
5	84	Door	17	2	NC	18	3	SC
	85			3	SC		4	TC
	86			4	TC		1	FC
	87			1	FC		2	NC
	88			3	NC		4	SC
	89			4	SC		2	FC
	90			1	TC		3	NC
	91			2	FC		1	TC
	92	Window	19	2	SC	20	3	TC
	93			3	TC		2	SC
	94			4	FC		1	NC
	95			1	NC		4	FC
	96			3	FC		2	TC
	97			2	TC		4	NC
	98			1	SC		3	FC
	99			4	NC		1	SC

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